REPORT NO. RK-TR-62-10

COPY 21

SAFETY CONSIDERATIONS WITH ELECTROEXPLOSIVE DEVICES

26 November 1962

291 043

U S ARMY MISSILE COMMAND
REDSTONE ARSENAL ALABAMA

ASTIA Availability Notice

Qualified requestors may obtain copies of this report from ASTIA.

Destruction Notice

Destroy; do not return.

26 November 1962 Report No. RK-TR-62-10

SAFETY CONSIDERATIONS WITH ELECTROEXPLOSIVE DEVICES

By

R. E. Betts

Propellant Chemistry Branch
Propulsion Laboratory
Directorate of Research and Development
U. S. Army Missile Command
Redstone Arsenal, Alabama

TABLE OF CONTENTS

	Page
DEFINITION AND DESCRIPTION OF ELECTROEXPLOSIVE DEVICES	
Functioning	1
Associated Hazards	1
SAFETY MEASURES AND PRECAUTIONS	
Design Safety of an EED	6
Handling Precautions with EED's	7
Testing Methods for Determining EED Safety	8
CONCLUDING REMARKS	9
APPENDIX A	13
APPENDIX B	14

LIST OF ILLUSTRATIONS

Figure		Page
1	Views of Three Types of Electroexplosive Devices	2
2	Firing Energy Range of Typical EED's	3
3	Cross Sections of Squib	5
4	Schematic of Functional Test Circuit	10
5	Energy Required to Fire a Squib by Capacitor Discharge	11

DEFINITION AND DESCRIPTION OF ELECTROEXPLOSIVE DEVICES

Electroexplosive devices (EED's) are ordnance items which are initiated by electrical means. Such items include squibs, detonators, primers, initiators, blasting caps, explosive bolts, etc.; and among their usage are included ignition of rocket motors, closing switches, and activation of thermal devices.

Normally there are four basic parts to an EED: (1) A plug in which are embedded electrical leads; (2) an electrical bridge; (3) an initiating charge; and (4) a housing envelope. Plug materials may be of rubber, plastic or ceramics. In most cases these plugs are insulators, but in some instances conductive or semiconductive materials are used. The leads may be solid or stranded wire or pins which may range in length to a fraction of an inch to several feet; many devices have only one lead, and the housing envelope used as the other electrical connection. Bridges may be fine wires of either high or low resistance, semiconductive materials, carbon coatings, spark gaps, or a conductive pyrotechnic. The initiating charge may be a very sensitive primary explosive such as mercury fulminate, an intermediate composition such as metal fuel-inorganic salt oxidizers, or very insensitive secondary explosive and composition, such as diluted PETN or metal metal-oxide formulations. The housing envelopes are normally metal. Figure 1 shows views of three types of EED's.

Functioning

As defined, an EED functions with the application of electrical energy through the leads. Heat is produced in the bridge and transferred to the initiating charge. When energy is delivered to the charge in sufficient quantities and time to raise the charge to its ignition temperature, ignition occurs. The level of energy to cause EED functioning ranges less than 100 ergs for some carbon bridge-type detonators to greater than 10,000,000 ergs for some exploding bridgewire-type squibs. (See Figure 2.)

Associated Hazards

The hazard brought about by human error can never be eliminated. The author will not elaborate on this field of safety, but it should be noted that the human error factor should be heavily weighed when designing EED's. Reduction of accidental firing by human error can best be minimized by designing sequential controlled events to produce functioning. The reliability of the system using the EED is then the controlling factor in the use of sequential events.

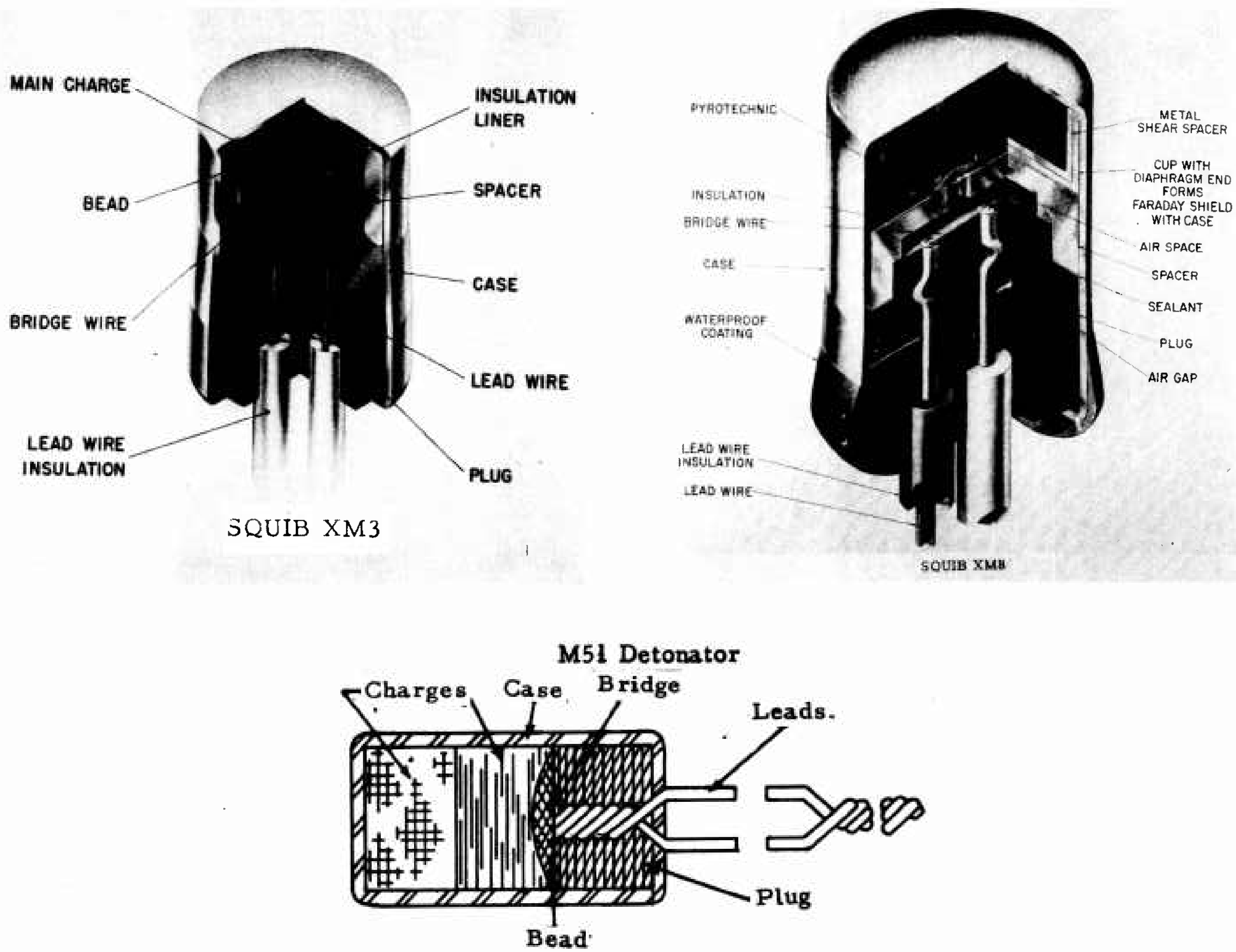


Figure 1. - VIEWS OF THREE TYPES OF ELECTROEXPLOSIVE DEVICES

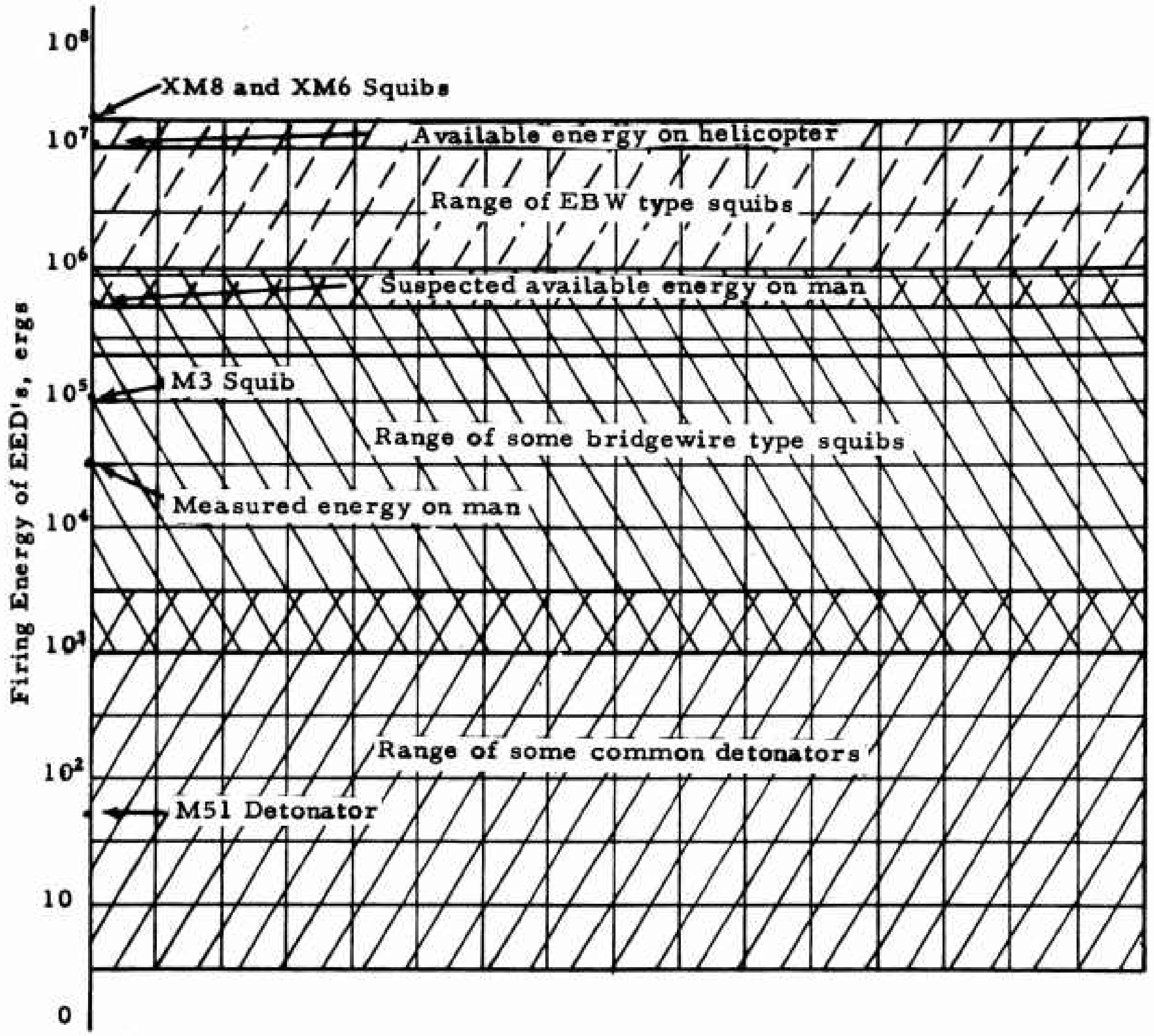


Figure 2. - FIRING ENERGY RANGE OF TYPICAL EED's

Three main electrical hazards associated with EED's are: Electrostatic, radio-frequency indications, and induction from high-current transmission lines. Electrostatic energy can cause EED initiation by heating the bridge or directly heating the explosive charge. Figure 3 shows conditions which cause EED functioning from electrostatic energy.

Figure 3-A shows a condition to exist where one lead is grounded and the energy source contacts the other lead. Since all the energy flows through the bridge, the degree of safety is dependent only on the condition affecting the bridge.

As shown in Figure 3-B, the conditions are the same as 3-A except the leads are shorted together. As such, the bridge is then placed in a parallel circuit with the leads; the energy flow or current is then divided with the amount of flow being inversely proportional to the resistance. Hence, if the lead resistance is large in comparison to the bridge, the bridge receives more current. The point of contact where energy is applied also controls the current to the bridge. It is seen that in applying energy at point (1), more current flows through the bridge than application at point (2) (this point having lead resistance in series with the bridge); thus minimum energy to the bridge may be accomplished by applying energy as close to ground as possible. Since electrostatic energy is a pulse, impedence of the load will determine the amount of energy received. If the bridge portion of the circuit is matched with the energy source and energy-source transmission lines, more energy will be received by the bridge.

Figure 3-C is a sketch showing the energy passing directly through the initiating composition to the bridge lead circuit. By this method the degree of safety is dependent upon bridge characteristics and upon the characteristics of the charge itself. In some cases, the energy required to fire an EED is less when passing through the composition than when passing through the bridge. Thus it is obvious that a given electrostatic sensitive composition would have the same degree of safety for conditions through the composition regardless of the bridge characteristics.

The sketch of Figure 3-D shows that energy is transferred to the EED at a point at which localized heating occurs and is transferred to the initiating composition by conduction. Functioning is then dependent upon the thermal characteristics of the initiating composition and the material initially receiving the energy.

Figure 3-E is the same condition as 3-A but having the case as one of the leads.

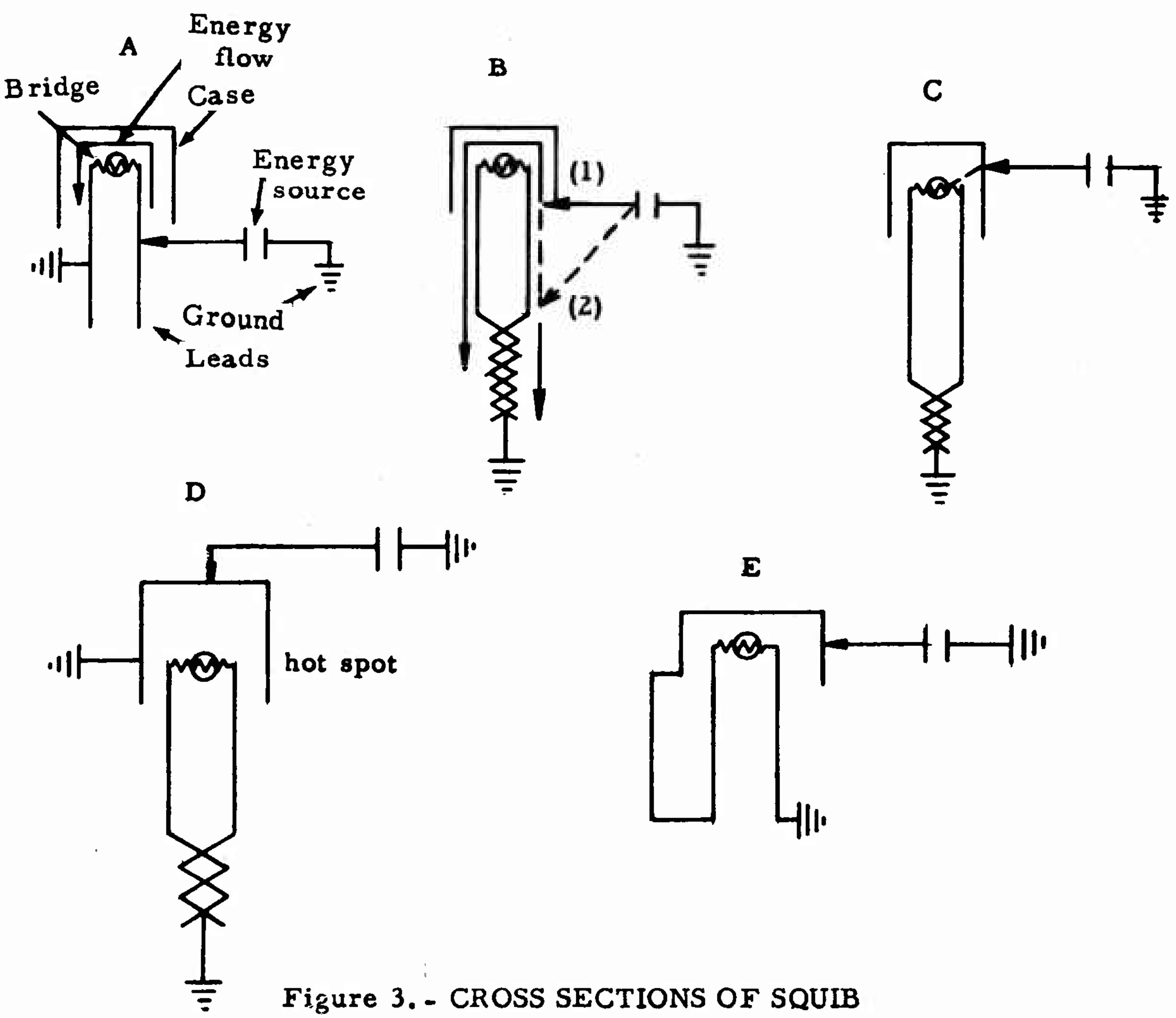


Figure 3. - CROSS SECTIONS OF SQUIB

Radio-frequency energy (RF) can enter an EED through the leads either by a direct connection to the transmitting source or by an antenna coupling. There is very little chance of a direct connection unless RF sources are used in EED checkout instruments. The greatest potential hazard is then through an antenna coupling, and there is an indefinite number of conditions for such coupling to occur.

For any lead configuration, there is an RF source which can be matched for maximum input and vice-versa. For all configurations, the parameters of safety are dependent only on the strength of RF energy source at the configuration, distance between source and the EED, and the tuning capabilities of the configuration. An object adjacent to an EED can reflect or focus radio frequency, thereby increasing the effective strength of the source or changing the tuning capabilities of the configuration.

When EED leads are placed near transmission lines carrying high current, energy is transferred to the leads by simple induction. For any given induced current, the safety level is dependent only on bridge characteristics.

SAFETY MEASURES AND PRECAUTIONS

Design Safety of an EED

The design of an EED is not straightforward. The factors controlling the design are dependent upon the purpose for which the EED is to be used and upon the available firing source. To discuss a design properly, it is probably best to take a specific example and show how safety is built in. Such an example is the M3 squib. First, the plug material was evaluated. An insulator was chosen over a semiconductor because it will permit the firing source to be applied to the bridge without energy loss, and it will also insulate the case from the lead, thus insulating electrostatic potential to some high voltage level. If a semiconductor material were used, the plug would attentuate RF-type energy at some specific frequencies; however, this type of plug would also pass electrostatic energy or other extraneous electrical energy, and in doing so would heat up, thereby causing the EED to function through heat transfer by conduction. The pyrotechnic for this squib was chosen because of its performance characteristics with respect to factors other than electrical. This pyrotechnic is somewhat static sensitive.

From Figure 1 showing the M3 squib, it is seen that spark passing through the composition of main charge or bead could initiate the squib. In this particular case, the bead controls the functioning performance of the squib, and the main charge is merely a booster-type charge. Additives such as conductive graphite and aluminum powder were added to the main charge to reduce static sensitivity. For the bead, an additive to reduce sensitivity could not be used without changing its functioning characteristics; therefore, a conductive coating was applied to the bead as a shield. If electrostatic energy entered into the squib and through the main charge to the bead, this shield would absorb the energy over a broader area. It would not permit sparking to occur within the bead but only on the non-sensitive surface. As a further protection a plastic insulator was placed between the pyrotechnic and the case. This also increases the breakdown voltage required to arc through the pyrotechnic.

Another example of squib safety design is the XM8 squib which is an exploding bridgewire type. The plug material was chosen for the same reasons as the M3. In this particular case the pyrotechnic charge, although somewhat static sensitive, was encased in a complete metal Faraday shield; no electrostatic energy can build up in this composition. Arcing from electrostatic energy must pass to and around the shield rather than through the shield. The functioning of this squib may be considered analogous to the rupture of a pressure vessel; that is, as the bridgewire explodes, pressure within the air chamber is increased, temperature is increased, and the thin end of the Faraday shield is ruptured, exposing the pyrotechnic to the high pressure temperature conditions. It is seen then that electrostatic energy entering into the area surrounding the bridgewire, if in sufficient quantity to heat this area could also rupture the end of the diaphragm through the pressure-temperature phenomenon. To prevent arcing from occurring in this area, a thin insulating disc was placed between the Faraday shield and the exposed lead wires of the bridge. Arc-gap holes were also placed in the plug, exposing the case to the squib leads. These gaps then prevent current flow to a desired level. When this level is reached, sparking then occurs through these gaps since they are the path of least resistance, and thus safety has been achieved.

Handling Precautions with EED's

Whenever possible an EED should be encased in a metal shield and the shield grounded. This offers the greatest protection to all forms of extraneous energy sources. If EED's are used in the presence of RF sources and complete shielding cannot be accomplished, then the leads of the EED should be kept as short as possible and should be twisted together and shorted to ground. The lead bridge circuit should never have one side of the circuit common to other equipment, even to common ground since the bridge is in the circuit. This permits extraneous energy on the common side to pass through the bridge. The probability of stray energy getting on the common side is somewhat high. If the leads are shorted together, however, this short may be connected to common ground. This prevents a potential difference between the leads and ground. Care should be taken to avoid placing the EED near transmission lines servicing other equipment. If close proximity is unavoidable, the EED leads should be placed in an appropriate shield and the shield grounded. If shielding is a problem, the leads and lead circuitry should be twisted to minimize induction. If the leads are to go through a bulkhead or some similar device, they should not be near other circuits carrying high voltage. High-voltage terminals through bulkheads or in a junction box might arc to the EED lead configuration.

When operators are handling EED's directly, the EED should be at ground potential and the operator should be a ground potential. An operator who is grounded by means of wire or wrist band directly to ground can build up static charges, particularly if his movements are on insulating devices above ground. The voltages that a grounded man can obtain will be about one-tenth the value of a comparable ungrounded man. When using an EED for some particular performance, the usual procedure is to give a continuity check to the item just prior to use. There are certain procedures with which an operator performing this checkout procedure should do. First, he should make sure that the instrument used in making the measurements cannot deliver energy to to the EED to cause functioning. Secondly, he should insure that the instrument is in proper working order because these instruments carry their own power supply, and under some conditions of damage can deliver more than their rated power output. Thirdly, he should never check the EED unless he is sure that if functioning were to occur, no other damage could be possible to equipment and personnel other than the EED and the item in which the EED is being used. As an example in checking squibs for rocket use, the squib should be checked for continuity prior to installing it in the rocket. After installation it should not be checked unless the accidental firing of the rocket could cause no damage. All checkout procedures should be carried out remotely. Methods by which man can accumulate static energy and rules for electrical safety with EED's are listed in Appendix A.

Testing Methods for Determining EED Safety

The best method in determining safety limits of a particular EED is to expose the items to the energy level in question; however, to obtain higher reliability at some high confidence level requires a trememdous amount of EED's. Another method which has been accepted by the field is that of exposing the EED in question to the desired energy level on a go-no-go basis and obtain the 50 per cent point by the "Bruceton" method. The standard deviation can then be calculated from this data and the four σ limits taken to represent the 100-per cent and 0-per cent fire. From this data the 5-per cent and 95-per cent confidence limits can also be calculated. Although this is not truly accurate, these figures give reasonable assurance of the safety limits.

Figure 4 shows a test setup in determining the electrostatic safety limits for EED's. In this test setup, an equivalent capacitor representing either man, helicopter, or other electrostatic generating type devices is charged by means of appropriate power supply. A vacuum switch is used to discharge the capacitor to the EED. In determining electrostatic safety, the capacitance for which electrostatic energy is to be stored must be identical to the capacitance of the suspected hazard if correct information is to be obtained. The energy required to fire an EED from electrostatic energy is increased as the capacitance decreases; therefore, the energy required to fire an EED at some higher capacitance cannot be transposed mathematically to equal the energy required at some lower capacitance. It is suspected that this phenomenon is because of a decrease in efficiency to transmit energy as capacitance goes down. Figure 5 is a curve of a particular EED tested by this method. Note that at low capacitance the energy required for functioning is five times greater than at higher capacitance.

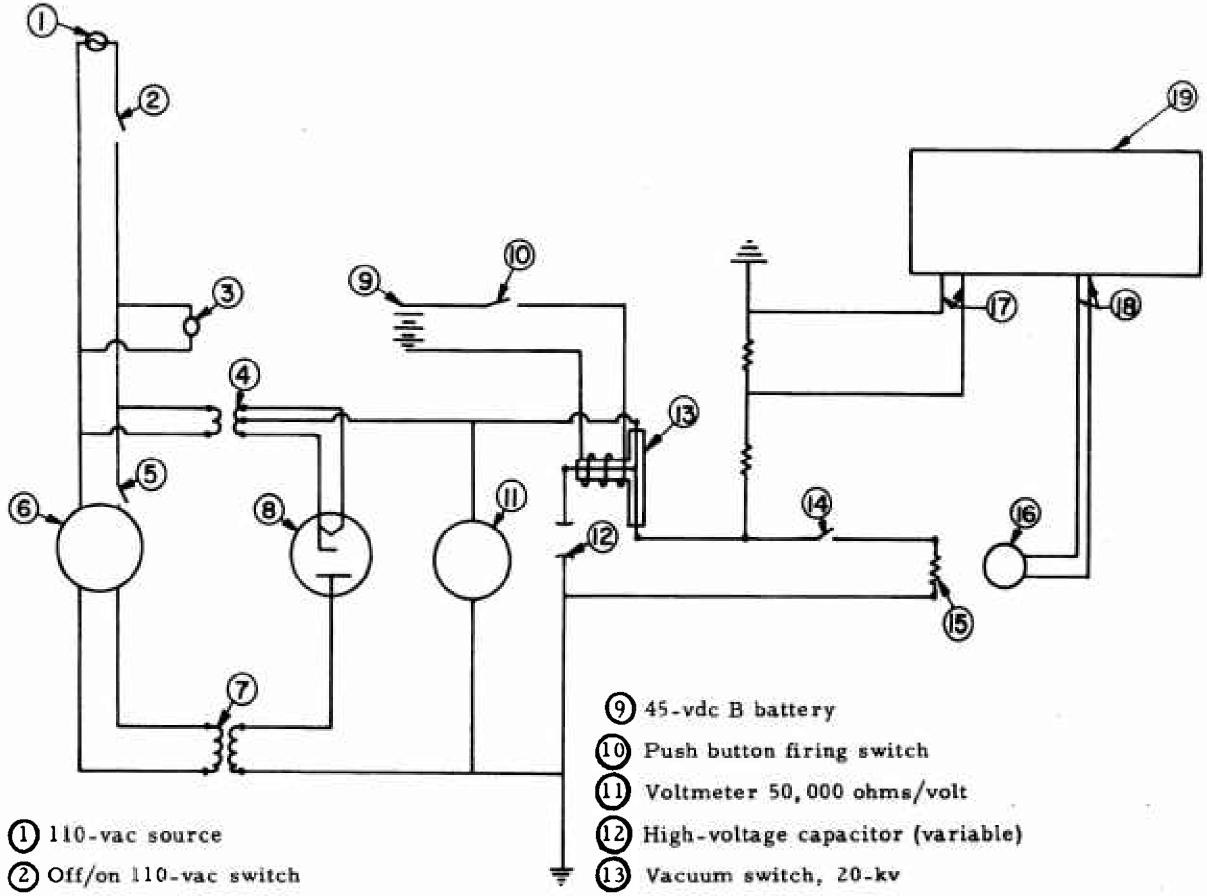
CONCLUDING REMARKS

In general the exploding bridgewire-type initiator offers the greatest protection to all forms of potential electrical hazards. It cannot be specifically stated that these devices should be used in all forms of rocketry since certain functions required in specific missile applications demand low-energy devices. However, when EED's are used which could cause catastrophic effects because of their accidental function, the exploding bridgwwire EED is of prime importance. Considering the present state of initiator art and the present potential hazards, EED's requiring one-half joule of functioning energy fulfill the demanding safety requirements and become applicable for missiles. It is not recommended or implied that exploding bridgewire EED should in themselves delete other safe-arming-type devices on missiles; although in some instances, the use of an explosive bridgewire-type EEDS alone with the reduction of the present safe-arming device would increase the safety characteristics of the missile in question.

From information available to date, an exploding bridgewire-type device should have the following safety characteristics:

(1) It should not function with applications of 1-amp current through the bridge when applied continuously for 8 hours. (It is understood that 1 amp has been measured in an initiator circuit from RF sources.)

(2) It should not function with the application or 0 to 100 amps of d.c. current or by heating, up to fusion, of the bridge.



1. 110-vac source
2. Off/on 110-vac switch
3. Warning light
4. Filament transformer, 2.5-volt
5. Off/on 110-vac switch
6. Power stat
7. High-voltage transformer, 5-kv, 500-ma
8. Tube, G.E. 816, 5000-vdc
9. 45-vdc B battery
10. Push button firing switch
11. Voltmeter 50,000 ohms/volt
12. High-voltage capacitor (variable)
13. Vacuum switch, 20-kv
14. Safety switch
15. Electroexplosive device
16. Phototube
17. Start circuit
18. Stop circuit
19. Electronic time-interval counter

Figure 4. - SCHEMATIC OF FUNCTIONAL TEST CIRCUIT

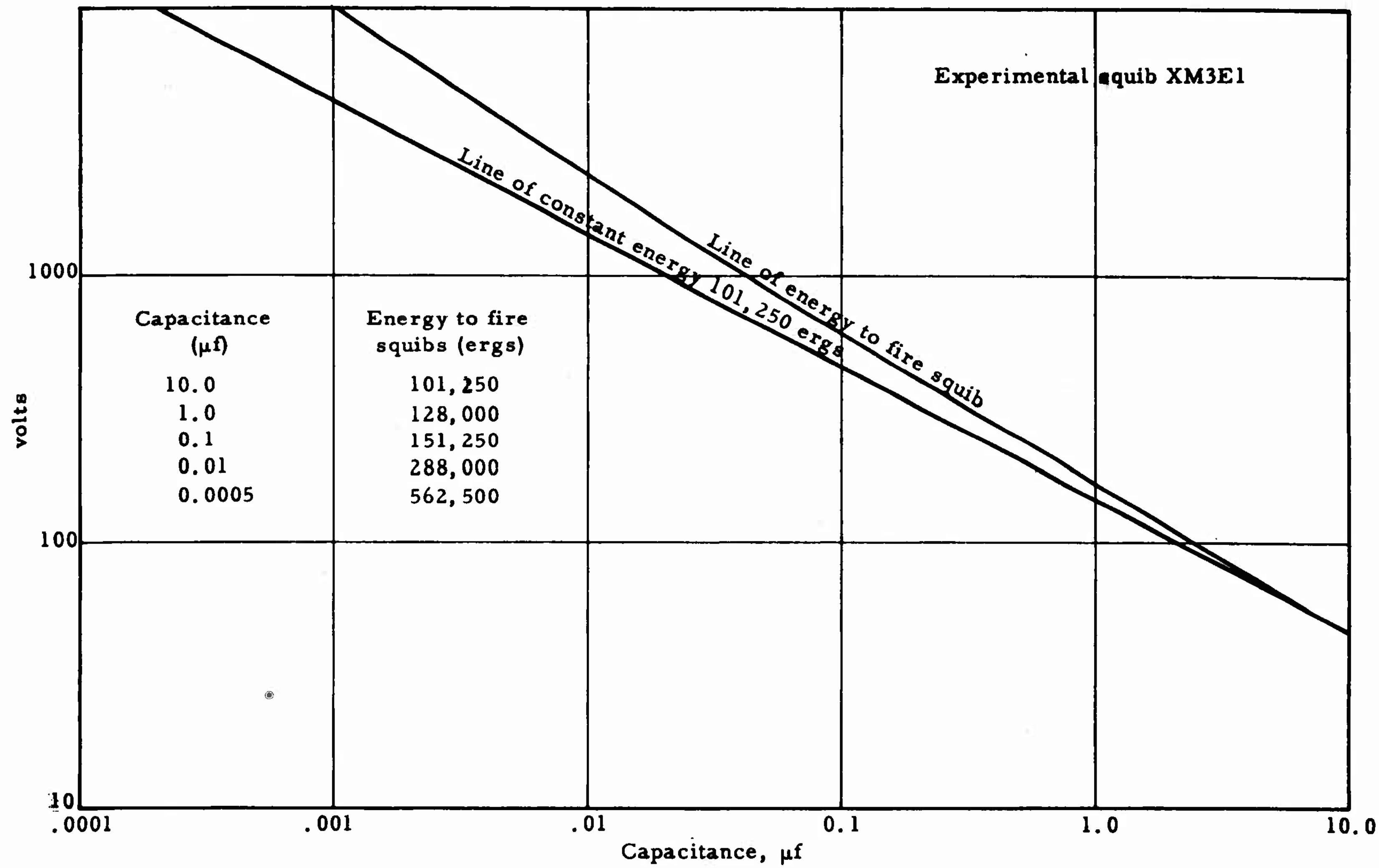


Figure 5. - ENERGY REQUIRED TO FIRE A SQUIB BY CAPACITOR DISCHARGE

(3) It should not function with the application of 32 volts from a low impedance source. This is the maximum voltage source most apt to be on missiles from battery-type devices.

(4) It should not function with the application of 220 volts, 400 cycles when applied either case to leads or through the leads. This power source is the maximum most apt to be at a missile site. Arc gaps or diodes placed in the lead circuit of an EED can make the EED safe to this condition through the bridge.

(5) It should not function with the application of 30,000 volts from a 3000-$\mu\mu f$ source, either case to leads or through the leads. This energy source is equivalent to the maximum measured on helicopters.

The Army's new XM6 and XM8 squibs met all the safety requirements, yet showed reliable functioning when fired from a 1-μf capacitor charged to 2000 volts through 16 feet of 52-ohm coaxial cable.

Brief descriptions of typical accidents associated with EED's are given in Appendix B.

APPENDIX A

Methods by Which Man Can Accumulate Static Energy

1. Movement across insulators.
2. Working adjacent to high-voltage equipment.
3. Handling insulator materials.

   a. Removing items from plastic bags.

   b. Stripping or unraveling plastic tapes.

4. Stand in high-velocity air currents.
5. Physical contact with equipment having capacitive characteristics, particularly transportation equipment.

Rules for Electrical Safety with EED's

1. Shield all components and ground to earth ground.
2. Short leads together and ground to earth ground.
3. Ground case to shorted leads.
4. Use low-energy checkout instruments (the maximum output should be no greater than 0.1 of the amount required for functioning).
5. Use floating circuits. (One side of EED circuit should not be common to chassis, frame, etc.)
6. Ground to earth all adjacent equipment. For example in loading rooms:

   a. Operator should wear conductive shoes, nonstatic clothing, and should be grounded by wrist band or the like.

   b. Table, chairs, stools, benches, floors, etc., should be metal or metal covered and grounded to earth.

   c. Electrical wiring entering the room should be shielded with shield grounded.

   d. Transformer-type devices should be shielded and grounded. (This includes fluorescent lighting fixtures.)

APPENDIX B

Typical Types of Accidents

1. ELECTROSTATIC

There have been many instances of accidental ignition of EED's by static charges from the human body. Recently one incident involved an operator packaging igniters for rocket use. The operator was stripping plastic tape from a roll, and packaging the igniters in plastic bags. The operator generated and collected static energy by handling the plastic tape and bags. When he touched the EED lead, the stored energy was enough to cause initiation.

2. RADIO FREQUENCY

Test around 1950 with radars required the placement of the EED only a few inches from the antenna horn to produce initiation. Recently an EED having .3-amp no-fire current was initiated 1120 feet from the antenna and 50 feet to the side of a highly directional radar beam. This comparison shows the extent to which the RF hazard has increased during the last decade. Aircraft rockets have been accidentially fired when brought close to RF transmitting sources. The radio transmitter on a jeephas caused initiation as the vehicle was driven near an aircraft. In one instance the rockets of a shipboard aircraft were fired when the ship's radio antenna was energized. In a test it was found that with a shipboard antenna energized, a man walking under an aircraft caused a rocket to fire. There was no physical contact between man and aircraft. Repeated tests showed this condition to be reproducible.

3. INDUCTION FROM TRANSMISSION LINES

A pilot was performing preflight checkout of on-board equipment. At some point in the checkout schedule, certain equipment requiring high operational current had to be energized. When the pilot closed the switch servicing this equipment, a rocket motor was initiated, destroying the plane and all its armament. The rocket ignition circuit was independent of the circuitry of the equipment being checked. An investigation of the incident concluded that the rocket igniter leads were adjacent to the lines of the equipment being checked. Initiation was caused by induction.

26 November 1962 Report No. RK-TR-62-10

APPROVED:

N. C. White

NILES C. WHITE
Chief, Propellant Chemistry Branch

Frank W. James

FRANK W. JAMES
Director, Propulsion Laboratory

DISTRIBUTION

	Copy
Solid Propellant Mailing List dated June 1962	1-127
Commanding General	
U. S. Army Missile Command	
Redstone Arsenal, Alabama	
Attn: AMSMI-R, Mr. J. L. McDaniel	128
-RK, Mr. F. James	129
-RKC, Mr. N. White	130
Mr. E. Betts	131-140
-RB	141-144
-RAP	145

AD ______________ Accession No. ________

Army Missile Command, Directorate of Research and Development, Propulsion Laboratory, Redstone Arsenal, Alabama.

SAFETY CONSIDERATIONS WITH ELECTROEXPLOSIVE DEVICES (U) - R. E. Betts.

Army Msl Cmd RK-TR-62-10, 26 Nov 62, 15pp - illus. Unclassified Report

This report defines and describes the general make-up of electroexplosive devices (EED). It covers the three basic electrical hazards of electrostatic, radio frequency energy, and induced currents, and the methods by which these hazards cause accidential initiation. General safeguards in designing and handling EED's for improved safety are included.

UNCLASSIFIED

1. EED--Description
2. EED--Hazards
3. EED--Ignition
4. EED--Safety measures
5. EED--Test methods
6. M3
7. M51
8. XM6
9. XM8

I. Betts, R. E.

DESCRIPTION: Copies obtainable from ASTIA, Arlington Hall Station, Arlington 12, Virginia.

AD ______________ Accession No. ________

Army Missile Command, Directorate of Research and Development, Propulsion Laboratory, Redstone Arsenal, Alabama.

SAFETY CONSIDERATIONS WITH ELECTROEXPLOSIVE DEVICES (U) - R. E. Betts.

Army Msl Cmd RK-TR-62-10, 26 Nov 62, 15pp - illus. Unclassified Report

This report defines and describes the general make-up of electroexplosive devices (EED). It covers the three basic electrical hazards of electrostatic, radio frequency energy, and induced currents, and the methods by which these hazards cause accidential initiation. General safeguards in designing and handling EED's for improved safety are included.

UNCLASSIFIED

1. EED--Description
2. EED--Hazards
3. EED--Ignition
4. EED--Safety measures
5. EED--Test methods
6. M3
7. M51
8. XM6
9. XM8

I. Betts, R. E.

DESCRIPTION: Copies obtainable from ASTIA, Arlington Hall Station, Arlington 12, Virginia.

AD ______________ Accession No. ________

Army Missile Command, Directorate of Research and Development, Propulsion Laboratory, Redstone Arsenal, Alabama.

SAFETY CONSIDERATIONS WITH ELECTROEXPLOSIVE DEVICES (U) - R. E. Betts.

Army Msl Cmd RK-TR-62-10, 26 Nov 62, 15pp - illus. Unclassified Report

This report defines and describes the general make-up of electroexplosive devices (EED). It covers the three basic electrical hazards of electrostatic, radio frequency energy, and induced currents, and the methods by which these hazards cause accidential initiation. General safeguards in designing and handling EED's for improved safety are included.

UNCLASSIFIED

1. EED--Description
2. EED--Hazards
3. EED--Ignition
4. EED--Safety measures
5. EED--Test methods
6. M3
7. M51
8. XM6
9. XM8

I. Betts, R. E.

DESCRIPTION: Copies obtainable from ASTIA, Arlington Hall Station, Arlington 12, Virginia.

AD ______________ Accession No. ________

Army Missile Command, Directorate of Research and Development, Propulsion Laboratory, Redstone Arsenal, Alabama.

SAFETY CONSIDERATIONS WITH ELECTROEXPLOSIVE DEVICES (U) - R. E. Betts.

Army Msl Cmd RK-TR-62-10, 26 Nov 62, 15pp - illus. Unclassified Report

This report defines and describes the general make-up of electroexplosive devices (EED). It covers the three basic electrical hazards of electrostatic, radio frequency energy, and induced currents, and the methods by which these hazards cause accidential initiation. General safeguards in designing and handling EED's for improved safety are included.

UNCLASSIFIED

1. EED--Description
2. EED--Hazards
3. EED--Ignition
4. EED--Safety measures
5. EED--Test methods
6. M3
7. M51
8. XM6
9. XM8

I. Betts, R. E.

DESCRIPTION: Copies obtainable from ASTIA, Arlington Hall Station, Arlington 12, Virginia.

AD______________ Accession No. __________

Army Missile Command, Directorate of Research and Development, Propulsion Laboratory, Redstone Arsenal, Alabama.

SAFETY CONSIDERATIONS WITH ELECTROEXPLOSIVE DEVICES (U) - R. E. Betts.

Army Msl Cmd RK-TR-62-10, 26 Nov 62, 15pp - illus. Unclassified Report

This report defines and describes the general make-up of electroexplosive devices (EED). It covers the three basic electrical hazards of electrostatic, radio frequency energy, and induced currents, and the methods by which these hazards cause accidential initiation. General safeguards in designing and handling EED's for improved safety are included.

UNCLASSIFIED

1. EED--Description
2. EED--Hazards
3. EED--Ignition
4. EED--Safety measures
5. EED--Test methods
6. M3
7. M51
8. XM6
9. XM8

I. Betts, R. E.

DESCRIPTION: Copies obtainable from ASTIA, Arlington Hall Station, Arlington 12, Virginia.

AD______________ Accession No. __________

Army Missile Command, Directorate of Research and Development, Propulsion Laboratory, Redstone Arsenal, Alabama.

SAFETY CONSIDERATIONS WITH ELECTROEXPLOSIVE DEVICES (U) - R. E. Betts.

Army Msl Cmd RK-TR-62-10, 26 Nov 62, 15pp - illus. Unclassified Report

This report defines and describes the general make-up of electroexplosive devices (EED). It covers the three basic electrical hazards of electrostatic, radio frequency energy, and induced currents, and the methods by which these hazards cause accidential initiation. General safeguards in designing and handling EED's for improved safety are included.

UNCLASSIFIED

1. EED--Description
2. EED--Hazards
3. EED--Ignition
4. EED--Safety measures
5. EED--Test methods
6. M3
7. M51
8. XM6
9. XM8

I. Betts, R. E.

DESCRIPTION: Copies obtainable from ASTIA, Arlington Hall Station, Arlington 12, Virginia.

AD______________ Accession No. __________

Army Missile Command, Directorate of Research and Development, Propulsion Laboratory, Redstone Arsenal, Alabama.

SAFETY CONSIDERATIONS WITH ELECTROEXPLOSIVE DEVICES (U) - R. E. Betts.

Army Msl Cmd RK-TR-62-10, 26 Nov 62, 15pp - illus. Unclassified Report

This report defines and describes the general make-up of electroexplosive devices (EED). It covers the three basic electrical hazards of electrostatic, radio frequency energy, and induced currents, and the methods by which these hazards cause accidential initiation. General safeguards in designing and handling EED's for improved safety are included.

UNCLASSIFIED

1. EED--Description
2. EED--Hazards
3. EED--Ignition
4. EED--Safety measures
5. EED--Test methods
6. M3
7. M51
8. XM6
9. XM8

I. Betts, R. E.

DESCRIPTION: Copies obtainable from ASTIA, Arlington Hall Station, Arlington 12, Virginia.

AD______________ Accession No. __________

Army Missile Command, Directorate of Research and Development, Propulsion Laboratory, Redstone Arsenal, Alabama.

SAFETY CONSIDERATIONS WITH ELECTROEXPLOSIVE DEVICES (U) - R. E. Betts.

Army Msl Cmd RK-TR-62-10, 26 Nov 62, 15pp - illus. Unclassified Report

This report defines and describes the general make-up of electroexplosive devices (EED). It covers the three basic electrical hazards of electrostatic, radio frequency energy, and induced currents, and the methods by which these hazards cause accidential initiation. General safeguards in designing and handling EED's for improved safety are included.

UNCLASSIFIED

1. EED--Description
2. EED--Hazards
3. EED--Ignition
4. EED--Safety measures
5. EED--Test methods
6. M3
7. M51
8. XM6
9. XM8

I. Betts, R. E.

DESCRIPTION: Copies obtainable from ASTIA, Arlington Hall Station, Arlington 12, Virginia.